APPENDIX A: SIMULATION MODEL USER'S GUIDE

The digital simulation program is written for a personal computer using a GUI. The program is started by double clicking on the selected icon. A window containing the main menu as shown in Figure A-1 will appear. Each button opens a window for the input parameters described in Section 2. This window will remain open until the user clicks on the Stop or Run option. The Stop option stops execution of the program, and the Run option executes the program for the selected parameters. For most options, a brief explanation will appear at the bottom of the window when the cursor is moved to a particular button or edit box (see Figure A-4 below for an example).

Clicking on the RF Signal button opens the window shown in Figure A-2 below. The user selects the modulation (push button format) and enters signal parameters. Default values are shown in the edit boxes. The Tab key can be used to step through the options. Parameters are set once the user clicks on exit (this closes the window). Each window can be revisited (and parameters changed) as often as desired prior to choosing the run option of the main menu.

Windows containing user options for the Amplifier, Channel, Inner Loop, and Outer Loop are shown below (Figures A-3 through A-6). In each case, push buttons and/or edit boxes are provided for user input. As before, user selections are registered upon exiting the window. Each window can be reopened and changes can be made as often as desired before the program is run.

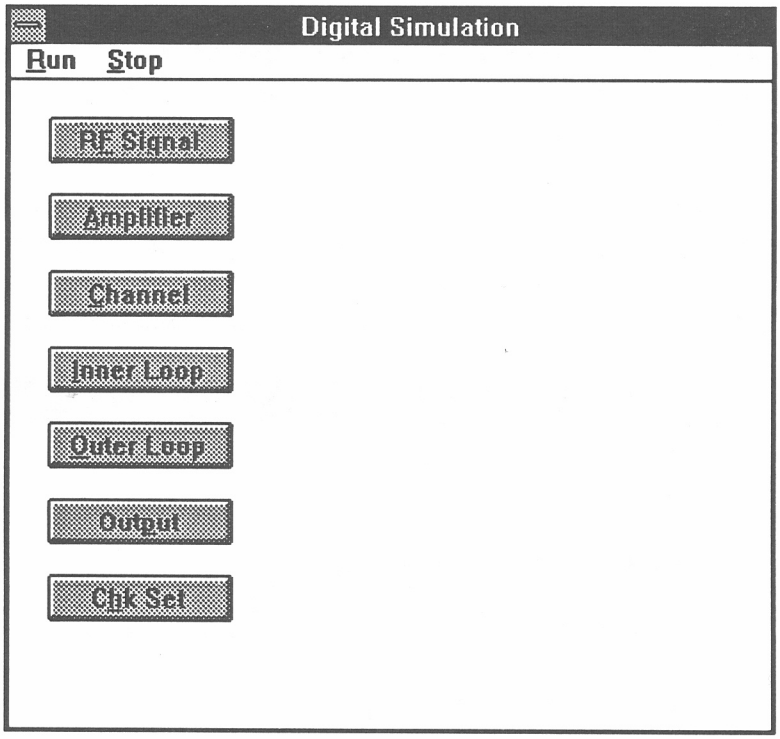

Figure A-1. Main menu for the digital simulation model.

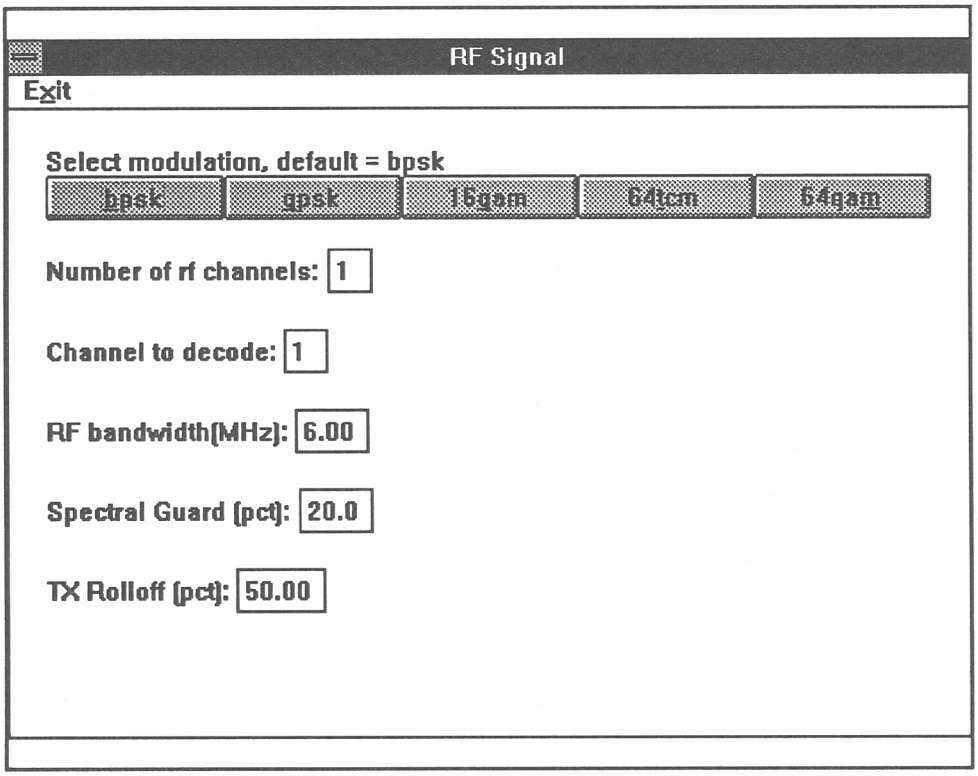

Figure A-2. RF signal menu.

The comment at the bottom of the window shown in Figure A-4 occurs when the user places the cursor on the "Turin" button. Other "help" messages appear at the bottom of each window when the cursor is moved to different options.

Note that in Figure A-5, the edit box for "Min Number of Symbols" is highlighted and there is a corresponding help message at the bottom of the window. When the edit box is highlighted, the desired value can be entered using the keyboard. Pushing the Tab key will highlight the next edit box "Max Number of Errors." Edit boxes will also respond to other standard editing keys (e.g., delete).

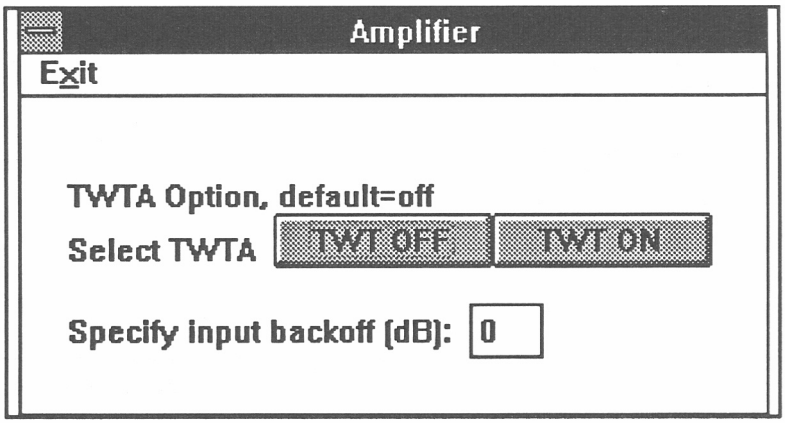

Figure A-3. Simulation model amplifier menu.

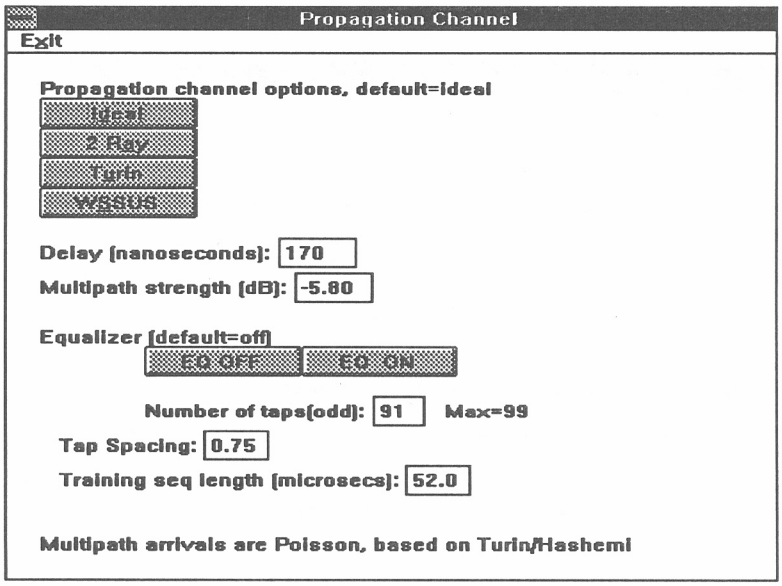

Figure A-4 Simulation model channel menu.

The "Output" menu is shown in Figure A-7. In this window, the user can select file names for the simulation by clicking on the appropriate "check box." Files are given default names as described later in this appendix. The user may edit these names. Note that file names are limited to eight characters + optional three character extension.

The "Chk Set" (check settings) option is provided so the user can review all of the parameter selections prior to running the program (Figure A-8). The parameters shown are used by the model unless the user returns to the main menu and makes additional changes. As with the other windows, the user must exit this window and then reopen the window to review any changes. Note that this window need not be used prior to running the program. This data is also automatically written to an

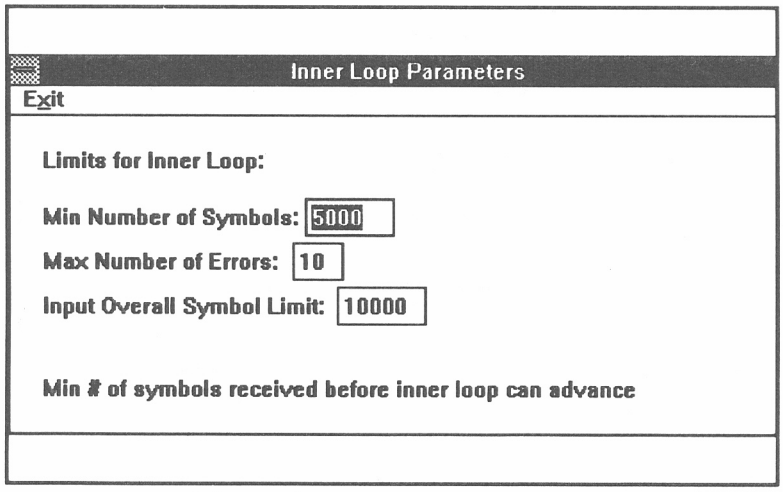

Figure A-5. Inner Loop menu.

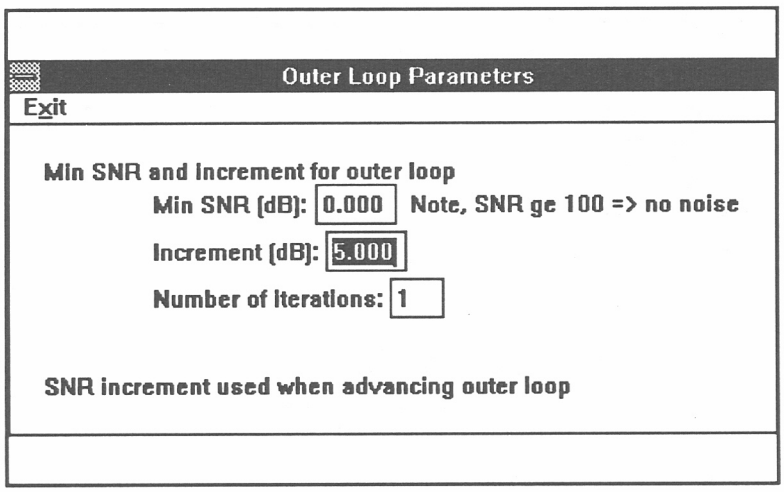

Figure A-6. Outer Loop menu.

ASCII file named input.xxx, where xxx are the three numbers corresponding to the default extension given to the output files.

If the settings are satisfactory, the simulation program can now be executed by returning to the main menu and clicking the Run button. The window containing the main menu will close and a data output window will appear as shown in Figures A-9 and A-10.

After displaying some preliminary data, the program displays the number of symbols received, the number of errors detected, and the ratio for each block of symbols received. This output allows the user to monitor the progress of the computation. In addition, Pause and Stop options are provided. The output window will continue to scroll until the program finishes. At this point, the output files

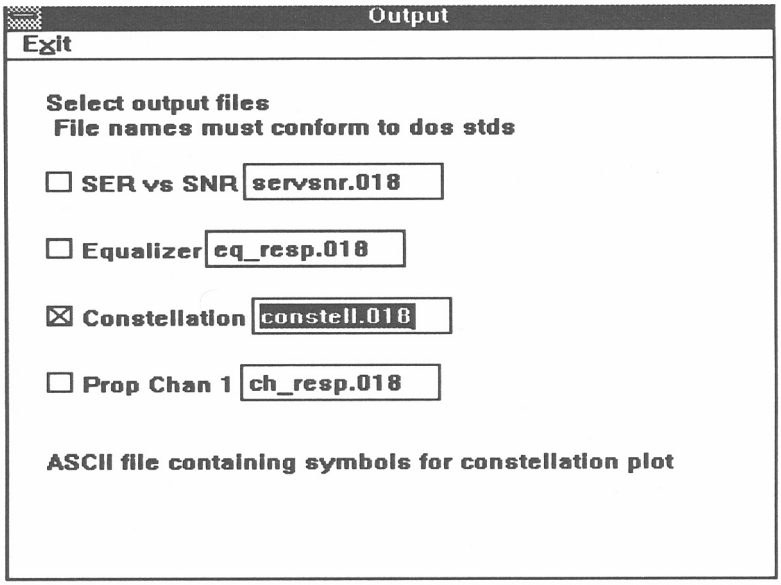

Figure A-7. Output menu.

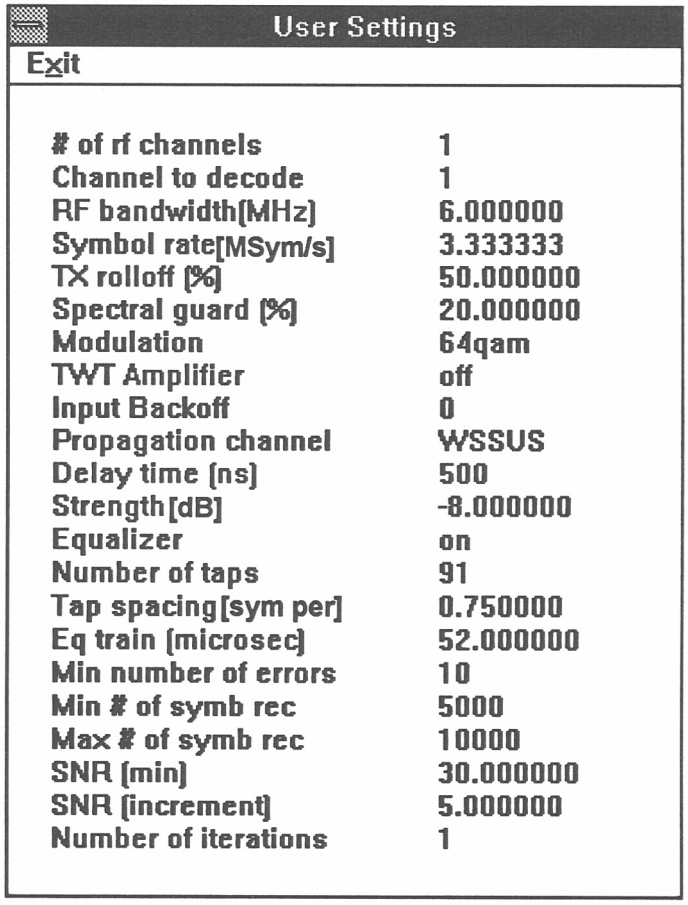

Figure A-8. User settings window.

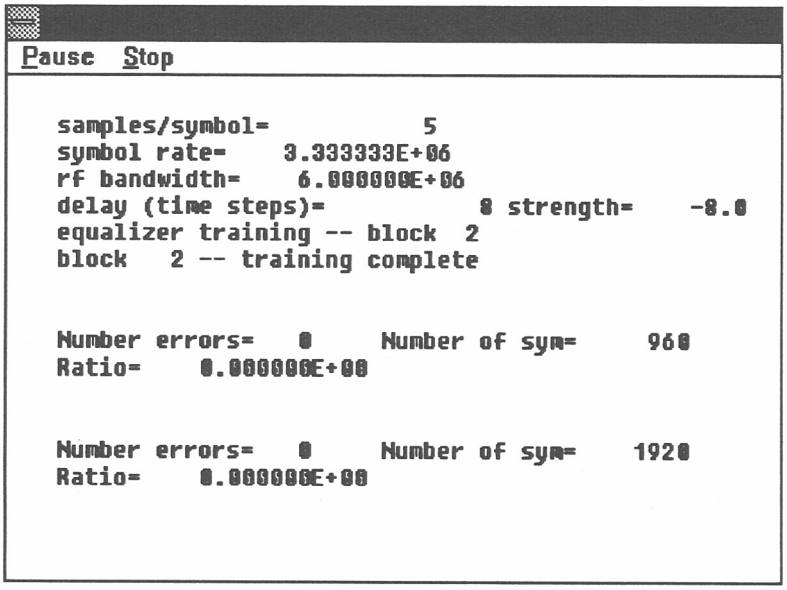

Figure A-9. Program starting output.

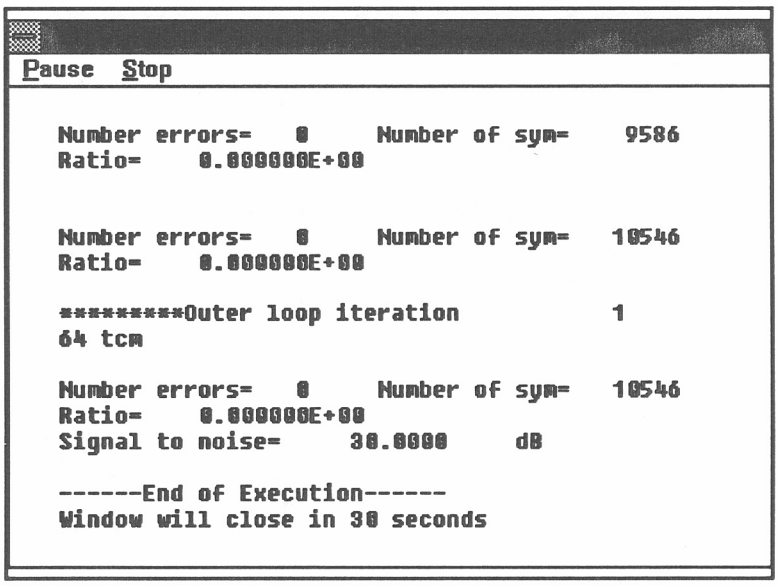

Figure A-10. Program ending output.

are closed and the required data may be accessed. The output window closes automatically after thirty seconds. The user may close the window manually using the Stop option.

The default output of the model is the calculated SER vs. SNR for the linear amplifier and carrier to intermodulation ratio (C/I), or carrier to intermodulation plus noise ratio (C/(I+N)) if the nonlinear amplifier is used. In addition, the user can select output files that show the symbol constellation, the equalizer impulse response, and the channel impulse response. The output files are written in ASCII format. In addition, a data file containing the user specified parameters is created each time the model is run. Each file contains the date and time of creation so it can be correlated with this data file.

The default file names are:

- input.xxx - default output detailing user-selected parameters;
- servsnr.xxx - default output of calculated symbol error ratio vs. signal to noise ratio;
- eq_resp.xxx - equalizer impulse response;
- constell.xxx - symbol constellation for a block of symbols; and
- ch_resp.xxx - channel response.

The extension xxx is a number based on the time the files were created. The user has the option to rename all of the files.

For multiple iterations of the outer loop, the constellation, equalizer and channel responses are only written to files for the first iteration. Examples of plots that can be created from the output files are given in Sections 2 and 3 of this report.

Most of the output files contain two columns of data that can be used to create two-dimensional “xy” plots. The channel response file contains several columns of data. The first column is time and the second column gives the magnitude of the channel. Typically this is the format in which channel response data is given. The magnitude of the channel response is given in dB. The other columns of data contain the real and imaginary components of both the unfiltered channel response and the filtered channel response. This data is linear, while the final two columns of data are the filtered channel response in dB. The additional data was used for diagnostic purposes and was maintained as an output that can be reviewed if desired.

On rare occasions, a coprocessor fault occurs. This appears to be connected with Windows® memory management and is most likely to occur when using applications which require significant system resources. Exiting Windows® and restarting the program will resolve the problem. Another error experienced on an infrequent basis is the argument of the logarithm function being zero. As the error is quite infrequent, its source has not been identified. Typically, the logarithm function is used to calculate decibels. In this case, the program must be restarted.

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The Institute for Telecommunication Sciences has developed a computer simulation model that can be used to predict coverage and quality of service for proposed terrestrial communication systems that broadcast digital television such as local multipoint distrubution services and multichannel multipoint distribution services. The model includes a variety of digital modualtion schemes that have been proposed for these services. The model also contains a nonlinear amplifier that allows the user to evaluate the effects of intermodulation distortion on performance. In addition to a simple additive white Gaussian noise channel, three different propagation channels are included; a simple two-ray channel, and two more complex channels based on measurements of broadband signals in various geographoic environments. A description of the simulation model as well as examples of applications are given in this report.

16. Key Words *(Alphabetical order, separated by semicolons)*

Digital broadcast services; local multipoint distribution services (LMDS); multichannel multipoint distribution services (MMDS); nonlinear amplifier; propagation channel model; traveling wave tube amplifier (TWTA)

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